INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

6 October 2011 (pm)

Subject ST9 — Enterprise Risk Management

Time allowed: Three hours

INSTRUCTIONS TO THE CANDIDATE

1. *Enter all the candidate and examination details as requested on the front of your answer booklet.*

2. *You have 15 minutes before the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have three hours to complete the paper.*

3. *You must not start writing your answers in the booklet until instructed to do so by the supervisor.*

4. *Mark allocations are shown in brackets.*

5. *Attempt all eight questions, beginning your answer to each question on a separate sheet.*

6. *Candidates should show calculations where this is appropriate.*

AT THE END OF THE EXAMINATION

Hand in BOTH your answer booklet, with any additional sheets firmly attached, and this question paper.

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.

1 The central risk team of a global insurance company is preparing for the introduction of a new risk based regulatory regime. The Chief Risk Officer for the insurance company has responsibility for preparing a set of new risk policies.

Outline the areas that should be covered in each risk policy. [4]

2 Investment Bank A is listed on the national stock exchange. It has grown rapidly in recent years and has operations around the world. It uses outsourcing arrangements to provide a large part of its services.

It has just appointed a new external director, who has commented that although the bank has implemented a risk management framework, it does not appear to have a very strong risk management culture.

(i) Discuss this comment. [4]

(ii) Propose ways in which the management of the bank could seek to improve the risk management culture. [5]

Life Insurer B is a domestic, unlisted life insurance company that sells retirement savings products. Investment Bank A is looking to acquire Life Insurer B in order to boost the scale of its investment management operations.

(iii) Outline how Lam's seven "key lessons learned" can assist the Board when integrating the risk management frameworks of the two businesses. [7]

[Total 16]

3 A large bank's trading book comprises hundreds of thousands of interest rate and foreign exchange rate swaps with a wide range of counterparties.

(i) Describe the main risks to the bank arising from its trading book. [3]

Historically such risks have been measured by estimating the daily volatility on interest rates for the interest rate swaps and by estimating the daily volatility on both interest rates and foreign exchange rates for the foreign exchange rate swaps. The Pearson's correlation coefficients between the various foreign currencies are also estimated and used in the risk calculations.

The bank is now developing a model to measure the amount of risk in the trading book, based on these daily volatility estimates and a correlation coefficient matrix for the various foreign currencies.

(ii) Describe the additional inputs that would be required in order to construct this risk model. [6]

(iii) Describe the outputs that should be produced by this risk model. [3]

(iv) Discuss the extent to which this risk model is likely to produce reasonable results. [5]

[Total 17]

4 Over the last few years the price of aviation fuel has generally been increasing, as has the volatility of the price. In response, UK based Snooze Air plc purchased futures contracts listed on the New York Mercantile Exchange relating to the company's forecasted usage of aviation fuel over the following 18 months.

(i) Describe why the company has purchased futures contracts. [2]

(ii) Describe the issues that might arise in relation to this mitigation strategy. [4]

[Total 6]

5 Let S_t and B_t be the value at time t of a firm's equity and debt respectively and V_t be the firm's value at time t. Then Merton's model at time t for the value of a firm, assuming frictionless markets, states that $V_t = S_t + B_t$.

If V_t is assumed to follow a diffusion model of the form

$$dV_t = \mu_V V_t\, dt + \sigma_V V_t\, dW_t$$

where μ_V is real and is the mean value of the firm, σ_V is greater than 0 and is the standard deviation of the value of the firm and W_t is a standard Brownian motion, then the default probability of the firm can be calculated as:

$$P(V_T \le B) = P(\ln V_T \le \ln B) = \Phi\left(\frac{\ln(B/V_0) - (\mu_V - \tfrac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}}\right).$$

where T is the term to maturity of the debt.

(i) Justify the above formula using economic intuition. [4]

The above form of the Merton model can be extended to include credit migration thresholds. It can be shown that the firm belongs to rating class j at time horizon T if and only if $d_j < X_T \le d_{j+1}$ where:

$$X_T := \frac{\ln V_T - \ln V_0 - (\mu_V - \tfrac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}},$$

$$d_j := \frac{\ln \tilde{d}_j - \ln V_0 - (\mu_V - \tfrac{1}{2}\sigma_V^2)T}{\sigma_V\sqrt{T}},$$

where $\tilde{d}_j$ is a ratings threshold (for example $\tilde{d}_1$ is the default threshold, e.g. the value of the firm's liabilities).

(ii) Explain how the firm's management and external credit analysts could use this threshold model for decision making purposes. [6]

[Total 10]

6 ABC is a life insurance company. It sells two product types, namely immediate annuities and term assurances, both of which are backed by portfolios of government bonds.

The two products are sold through different distribution channels. Recognising that the key risk exposures are quite different for each product (longevity and mortality respectively), ABC also has separate administration and back office functions for each product.

ABC has recently begun developing an economic capital model. It believes that these two products to some extent provide a natural hedge and it would like to reflect this in the model.

(i) Explain the role of diversification in measuring economic capital requirements. [2]

ABC has calculated the economic capital requirement for annuities and term assurances on a standalone basis to be £5.5 million and £2.25 million respectively. ABC has estimated that the correlation between the two blocks of business is 0.25.

(ii) Estimate the combined capital requirement and diversification benefit for the business, using a simple correlation matrix approach. [4]

(iii) Suggest an alternative modelling approach that could be used to recognise the natural hedge between the two product lines. [1]

The Business Development Manager has suggested that a third product line would help to increase the relative size of the diversification benefit available and has suggested selling a savings product with a guaranteed investment return.

(iv) Discuss this proposal. [5]

[Total 12]

7 Traditionally, most companies state that their primary objective is to increase profits from year to year. A well-known economist has recently said that, in most cases, a company's stakeholders would be better served if the company's primary objective was to operate at the limit of its stated risk tolerance.

Discuss this comment. [12]

8 (i) State the formulae that define Value at Risk (VaR) and Tail Value at Risk (TVaR). [3]

(ii) Outline the four axioms of a coherent risk measure. [4]

The Argyle Assurance Society currently uses a VaR approach when setting its risk based capital, assessing the 97.5% quantile over a one year time horizon.

The investment manager for the society is considering a portfolio of 20 independent corporate bond issues. The estimated probability of default on each of the bonds is 2% over the following year. The current price of each bond is £100,000. If there is no default on a particular bond then that bond pays £105,000 in one year's time. If there is a default on a particular bond then there is no payment in one year's time.

The investment manager has proposed two alternative strategies:

- Investment strategy A involves investing £2m in a single corporate bond issue from the portfolio.

- Investment strategy B involves investing £100,000 in each of the 20 corporate bond issues from the portfolio.

The following is a schedule of the cumulative distribution function for the binomial distribution with $n = 20$ and $p = 0.02$:

x	$F(x)$
0	0.6676
1	0.9401
2	0.9929
3	0.9994
4	1.0000

(iii) Calculate the VaR and TVaR for each investment strategy, using the given schedule. [8]

(iv) Discuss the suitability of using VaR and TVaR when setting the risk based capital for the society. [6]

(v) Explain which investment strategy should be recommended to the Board for approval. [2]

[Total 23]

END OF PAPER